R.12-03-014: LTPP Track II Workshop – SCE Operating Flexibility Modeling Results & Energy Division ELCC Modeling Efforts

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California Public Utilities Commission

September 18, 2013

Remote Access

WebEx

Meeting Number: 746 121 825
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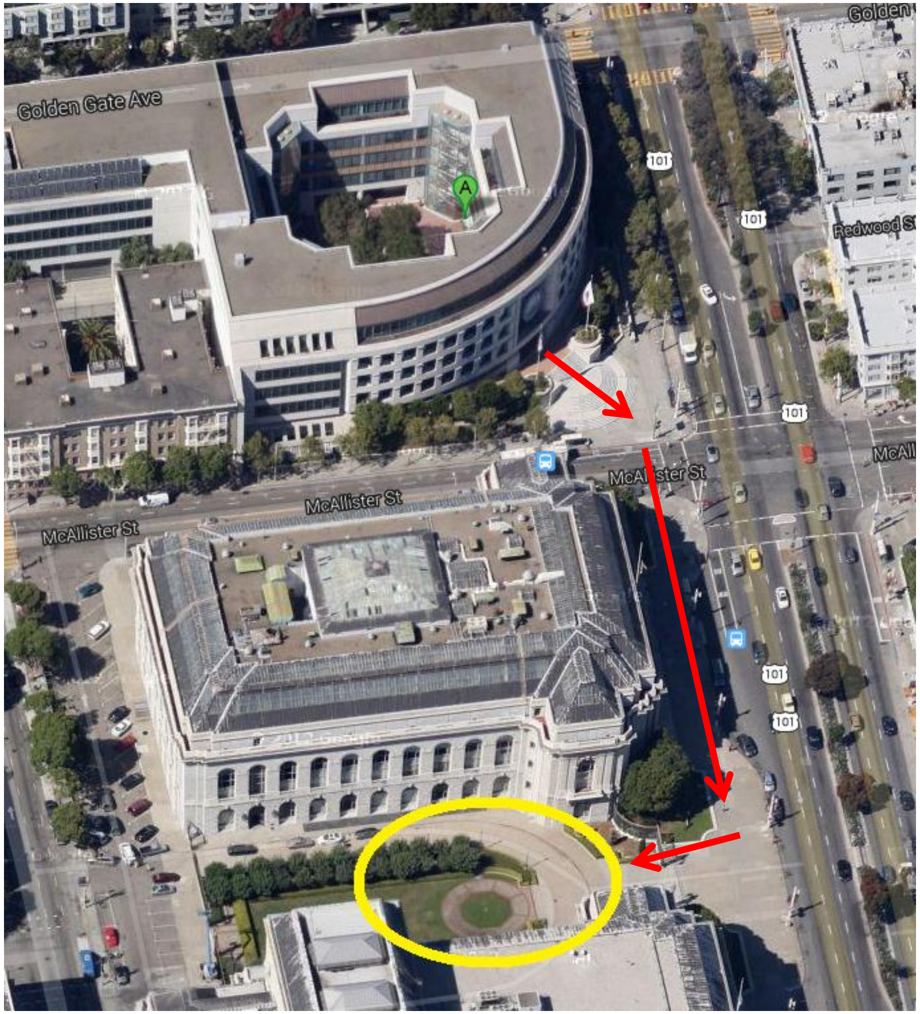
Agenda

Time	Item
10:00 – 10:10	**Introduction, Schedule**
10:10 – 12:15	**SCE Stochastic Model Study Results** Presented by Martin Blagaich, Senior Analyst, SCE
12:15 – 1:15	**Lunch**
1:15 – 2:15	**Q&A: SCE Stochastic Model Study Results** Presented by Martin Blagaich, Senior Analyst, SCE
2:15 – 2:30	**Break**
2:30 – 4:00	**Probabilistic Reliability Planning Project** Presented by Donald Brooks, Senior Analyst, Energy Division

Restrooms & Evacuation Procedure

Restrooms are out the Auditorium doors and down the far end of the hallway.

In the event of an emergency evacuation, please cross McAllister Street, and gather in the Opera House courtyard down Van Ness, across from City Hall.

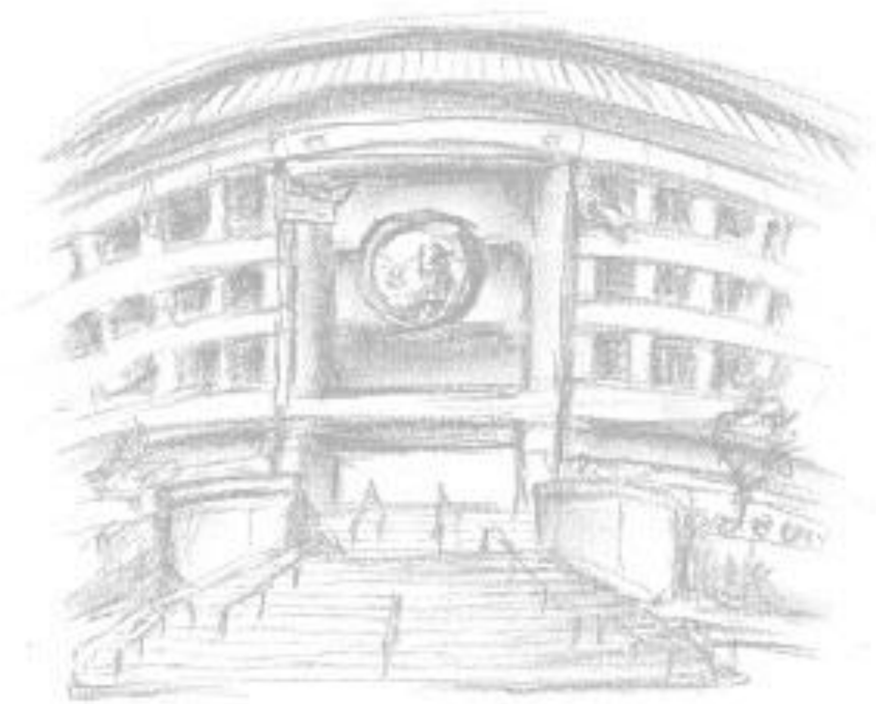


2012 LTPP Schedule

September	
18	**Stochastic Modeling Workshop:** SCE Operational Flexibility Modeling Results and Energy Division ELCC Modeling Efforts
30	**Track IV:** Reply to CAISO, SCE, SDG&E and City of Redondo Beach Testimony, and Opening Testimony of all other parties; Comments on ALJ Questions from 9/4/13 PHC
October	
14	**Track IV:** All Parties Rebuttal Testimony; expected Submission date if no evidentiary hearings; Reply Comments on ALJ questions from 9/4/13 PHC; final date to request evidentiary hearings
TBD	**Track IV:** Prehearing Conference
10/28 – 11/1	**Track IV:** Evidentiary Hearings
TBD	**Track IV:** Briefing Schedule
December	
1, or date of Reply Briefing	**Track IV:** Last Date to Request Final Oral Argument
TBD	**Track IV:** Proposed Decision, if no Evidentiary Hearings
Q1 2014	**Track IV:** Proposed Decision, if Evidentiary Hearings
≥ 30 days after PD	**Track IV:** Decision on Commission Agenda

Thank you!
For Additional Information:

http://www.cpuc.ca.gov/PUC/energy/Procurement/LTPP/ltpp_history.htm



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SCE's Stochastic Analysis Results for Renewable Integration

September 18, 2013

Objective of Today's Presentation

Review the Results and Assumptions of SCE's Stochastic Analysis

Agenda

1. Project Background
2. 2022 Results of Base Case Without SONGS
3. Model Validation
4. Inputs and Assumptions
5. Conclusion and Next Steps

Project Background

Analysis uses stochastic draws of key variables to predict the likelihood that the generation fleet cannot meet 5-min net load.

Methodology Overview

Objective

- Determine if additional resources are needed for system reliability in 2022

Design Principles

- Generate realistic uncertainty in key variables
- Maximize number of possible simulations within a reasonable timeframe
- Rely on publically available information

Key Features

- Stochastic method tests a range of net load (load minus wind and solar)
- 5-minute granularity to understand appropriate level of system need and fleet capability
- Calculate a loss of load probability (LOLP)

The largest change in modeling from the 2010 LTPP is the use of stochastic variables and the move to 5-minute granularity.

Summary of SCE's Modeling Differences

Item	2010 LTPP Deterministic Modeling	SCE's Stochastic Analysis
Load Peak and Shape	1 Draw	Stochastic Analysis
Intermittent Generation	1 Draw	Stochastic Analysis
Maintenance and Forced Outages	1 Draw	Stochastic Analysis
Dispatch Granularity	1 HR	1HR & 5 Minutes*
Dispatch Horizon	8760 hours	One day for each season; but many samples
Economics	Full	Limited
Reserve Shortfall	Net Load Following / Regulation / Contingency	Regulation / Contingency
CA Detailed Modeling (Generation, Transmission, Constraints)	Yes	Yes
Reliability Measure	Reserve Shortfall	Loss of Load Probability

*5-Minute dispatch runs test the accuracy of the hourly dispatch results

Modeling utilizes a combination of stochastic and static inputs and analyzes them on an hourly and 5-minute granularity basis.

Analysis Overview

Stochastic Inputs

- Load
- Intermittent Generation
- Scheduled and Forced Outages

Static Inputs*

- SCIT and CA Import Limits
- Hydro Levels and Daily Energy
- Non-Intermittent Must Take Energy

PLEXOS Processing

Hourly Analysis

- Capacity and Ramping Shortfall
- Other Constraint Violations (60/40 rule, SCIT, etc.)

5-Minute Analysis

- Verification of the Hourly analysis

*Does not include all static inputs, just examples

2022 Base Case Without SONGS Results

PRELIMINARY

1 event in 10 years is the reliability standard in system planning.

System Reliability Standards

- Based on reliability standards, resources are needed if more than one Stage 3 System Emergency is expected to occur in 10 years
  - Stage 3 Emergency: When reserves drop below 3% of load and rotating outages are authorized to begin
  - 1 Event* in 10 Years: The acceptable occurrence of stage 3 events occurring

SCE's analysis finds that expected stage 3 emergencies are less than one in ten years, resulting in **no need for additional resources for system reliability**

*Event is defined as any day with one or more periods of a stage 3 emergency

SCE expects there will be additional resources available in 2022 that were not included in SCE's analysis.

Base Case without SONGS Results

Expected Stage 3 Emergencies	1.24
MW Deficiency (Approx.)	300 MW

While modeling results show a deficiency, the modeling assumptions did not account for resources that could exist in 2022 and further lower the Expected Stage 3 Emergencies.

Capacity Sources Not Counted in Modeling Assumptions

- **Track 1 LCR Authorized Procurement** – Only 1,000 MW of 1,500 MW modeled (200 MW LA Basin, 300 MW Big Creek / Ventura not modeled but is expected to exist by 2022)
- **40 Year Retirement Assumption** – 1,700 MW of thermal generation is assumed to retire before 2022 because of the 40 year lifespan assumption. Generation commonly continues operations past 40 year, allowing the 1,700 MW to possibly exist in 2022.
- **Track 4 LCR**– No resources were added to replace SONGS for local capacity needs (MW need for SONGS replacement is being determined in Track 4 of the 2012 LTPP)
- **Storage Proposed Decision** – 50 of the 1,325 MW of storage in the CPUC Storage Proceeding proposed decision was modeled [R.10-12-007]

Stage 3 Emergencies have the highest probability of occurrence in the Summer and Fall seasons.

Results Breakdown by Season

Season	Expected Stage 3 Emergencies	Months in Season
Spring	0	April, May
Summer	0.89	June, July, Aug
Fall	0.35	Sep, Oct
Winter	0	Jan, Feb, Mar, Nov, Dec
Total	**1.24**	

- Stage 3 Emergencies have the highest probability of occurrence in the Summer and Fall seasons
- Spring and Winter do not show any expected emergency events due to their low net loads

Stage 3 emergencies are seen predominantly in the highest net load groups.

Results Breakdown by Net Load Group

- Analysis is performed by net load groups (groups based on net load peak and net load 3-hour ramp).
- Expected stage 3 emergencies are highest in the high net load peak group.

Probability (%) of Stage 3 Emergency within Net Load Groups*

Summer		Net Load Peak Group		
		< 95%	95%-99%	99% +
3 Hour Net Load Ramp Group	< 25%	0%	0%	1%
	25% - 50%	0%	0%	6%
	50% - 90%	0%	0%	4%
	90%-95%	0%	0%	45%
	95%-99%	0%	0%	80%
	99% +	0%	0%	78%

Fall		Net Load Peak Group		
		< 95%	95%-99%	99% +
3 Hour Net Load Ramp Group	< 25%	0%	0%	0%
	25% - 50%	0%	0%	0%
	50% - 90%	0%	0%	11%
	90%-95%	0%	0%	17%
	95%-99%	0%	0%	2%
	99% +	0%	0%	0%

*Some numbers too small to show up as non-zeros, these results are highlighted in yellow

The confidence interval of SCE's analysis is relatively narrow.

Results Confidence Intervals

- Result intervals represent the uncertainty in the stochastic results. For example: "What if different draws were chosen in the model?"

- Confidence intervals are calculated using a statistical technique known as bootstrapping, a method commonly used to assess the accuracy of results from a small sample size of a large population.

Confidence Intervals for SCE Stochastic Analysis

Category	5th Percentile	Mean	95th Percentile	Standard Deviation
Stage 3 Emergencies	1.00	1.24	1.49	.15
MW Deficiency*	0	300	500	N/A

*Approximated values. Deficiencies do not account for all the MWs that have been authorized for procurement (see slide 8)

There is a need to export energy in 2022 to balance load and resources within CAISO.

CAISO Interchange

- SCE's analysis was not designed to study over-generation.
- Exports from CAISO do exist in the analysis
  - Exports are low relative to import levels:

CAISO Net Interchange (MW) Results

	Spring	Summer	Fall	Winter
Max Exports	2,169	3,568	1,287	1,344
Max Imports*	10,222	11,400	11,400	7,522
Average Net Interchange (Imports)	2,817	5,899	6,302	3,818

*Max imports into CAISO are limited by a 11,400 MW CAISO import limit

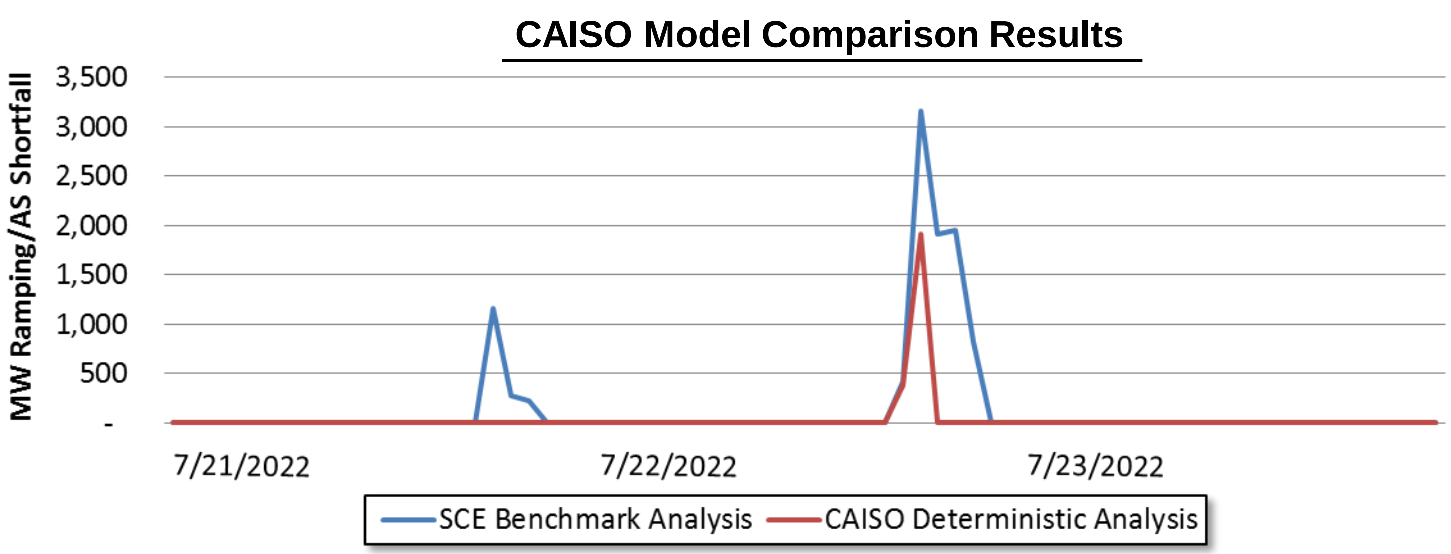
SCE's Model Validation

PRELIMINARY

SCE's conservative assumptions result in increased reserve shortfall when comparing against the CAISO's deterministic runs.

CAISO Model Comparison*

- A single deterministic case was run using SCE's model and CAISO's deterministic inputs to verify that SCE's model produced similar to the CAISO's model when using similar assumptions.
  - Deterministic Inputs Used: Renewable Generation, Load, Generator Outages, and Reserve Requirements
- SCE's model higher results show that:
  - The modeling changes made for stochastic analysis do not significantly affect results
  - The fleet assumptions used are conservative relative to CAISO's deterministic analysis



*Model was compared to 7/20/2013 published results, which does not include updates for Demand Response and Non Spin Imports into CA

The 2012 analysis shows a low probability of stage three emergencies using inputs from a known reliable year.

2012 Analysis

Expected Stage 3 Emergencies	<0.10
MW Deficiency	0 MW

- The purpose of the 2012 analysis is to test a historical year using SCE's methodology
- The 2012 analysis showed a very low probability of stage 3 emergencies, which is expected given historical operations and the high reserve margin

2022 Base Case Without SONGS Inputs and Assumptions

CAISO Area Load Forecast

- The analysis produced thirty potential load years for 2022 based on the scoping memo assumptions:

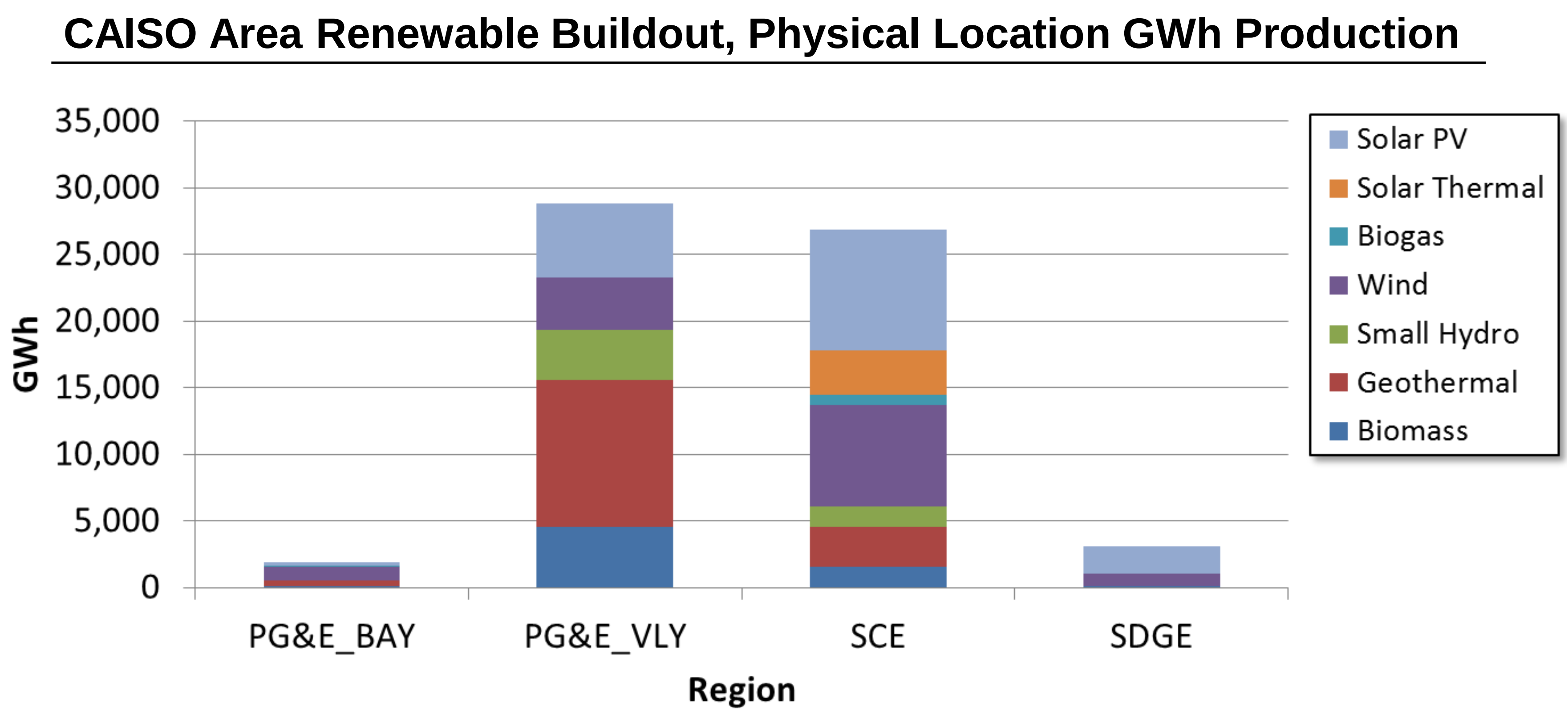
	SCE Analysis Average	Scoping Memo	% Difference
Peak (MW)	51,656	51,058	1.2%
Energy (GWh)	245,816	245,342	0.2%

- The thirty load years represent a wide range of potential outcomes that could occur in 2022:

	Max	90%	75%	50%	25%	10%	Min
Peak (MW)	59,145	54,586	53,542	51,453	49,936	47,282	46,115
Energy (GWh)	250,902	248,909	246,976	245,736	244,540	243,489	240,838

CAISO Area Renewable Generation Buildout

- Renewable generation buildout is based on the CAISO's Deterministic Base Case with SONGS Out analysis*

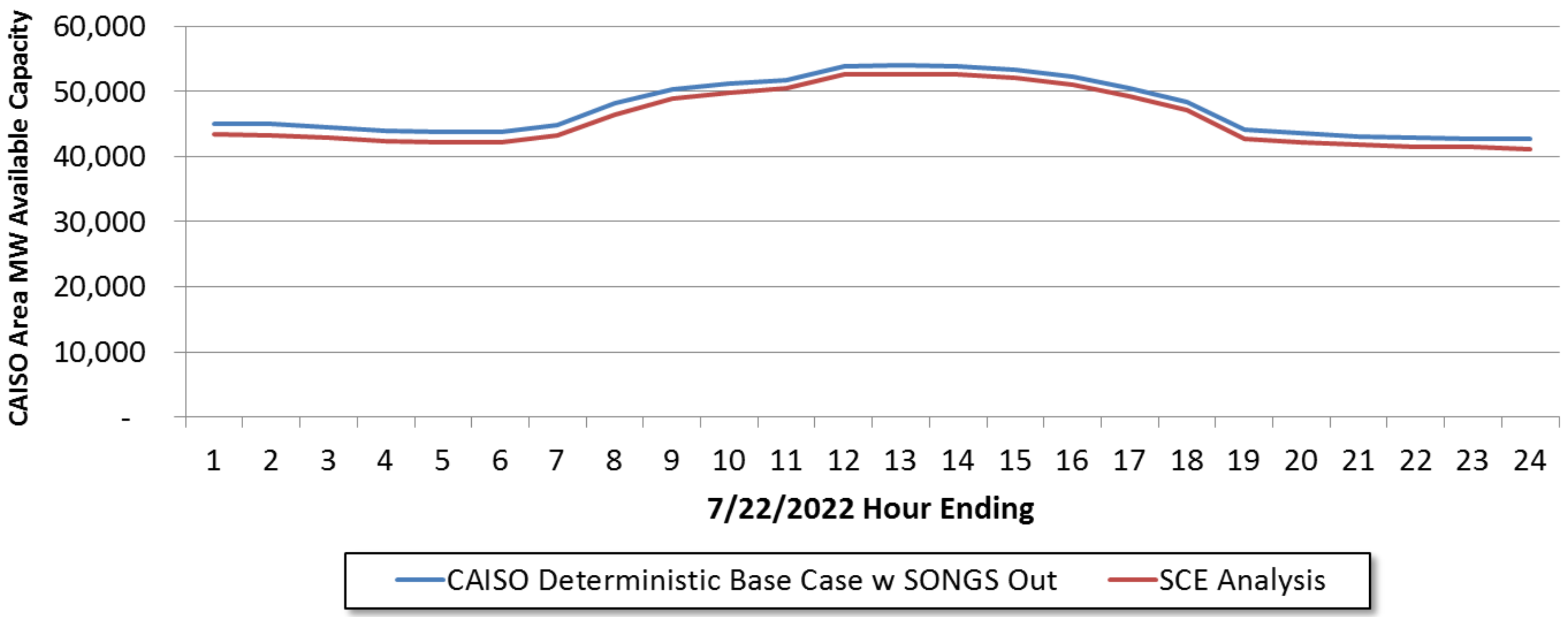


*Results published by CAISO on 2013-07-15

CAISO Generation Fleet Capacity

- SCE's fleet capacity assumptions are approximately 1% lower than the CAISO assumptions for Summer due to general rating and capacity differences.

SCE's Analysis vs CAISO Deterministic Analysis Generation Fleet Capacity*

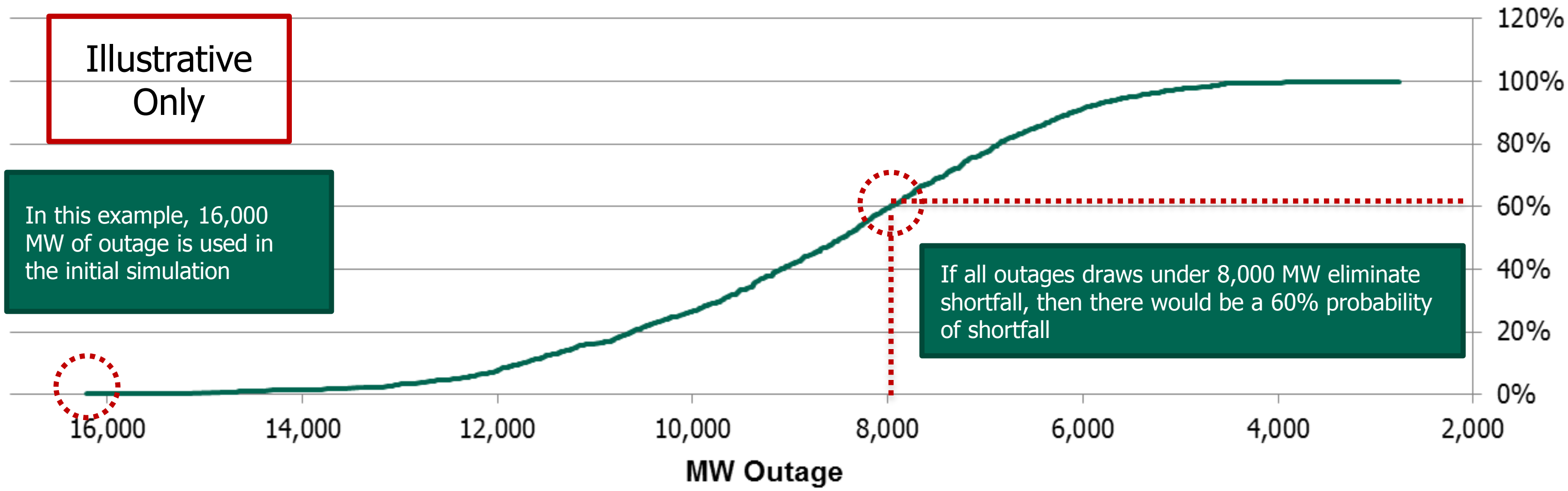


Compared to the database published by CAISO 7/2013

Maintenance and Forced Outage Analysis

1. Maintenance and Forced Outage draws are created using PLEXOS and CAISO outage factors
2. The highest outage draw is used in the initial simulation. Tests are performed to determine which outage draws would have resulted in the elimination of shortfall.
3. The total outage draws that result in shortfall will have their probability of occurrence applied to each net load draw

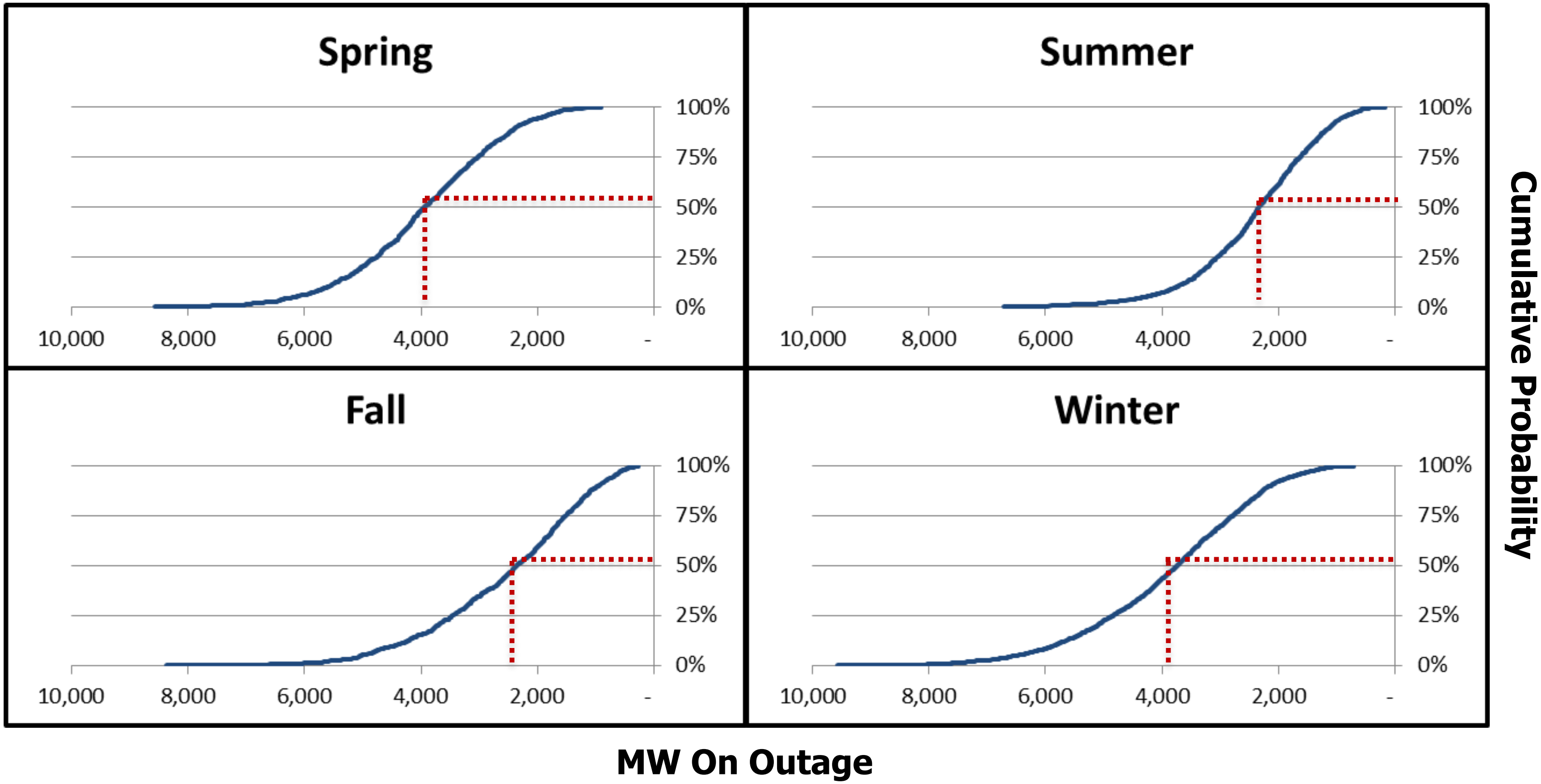
Total CA Outages (MW) Cumulative Probability Distribution Function Example



*Curve is different for each season

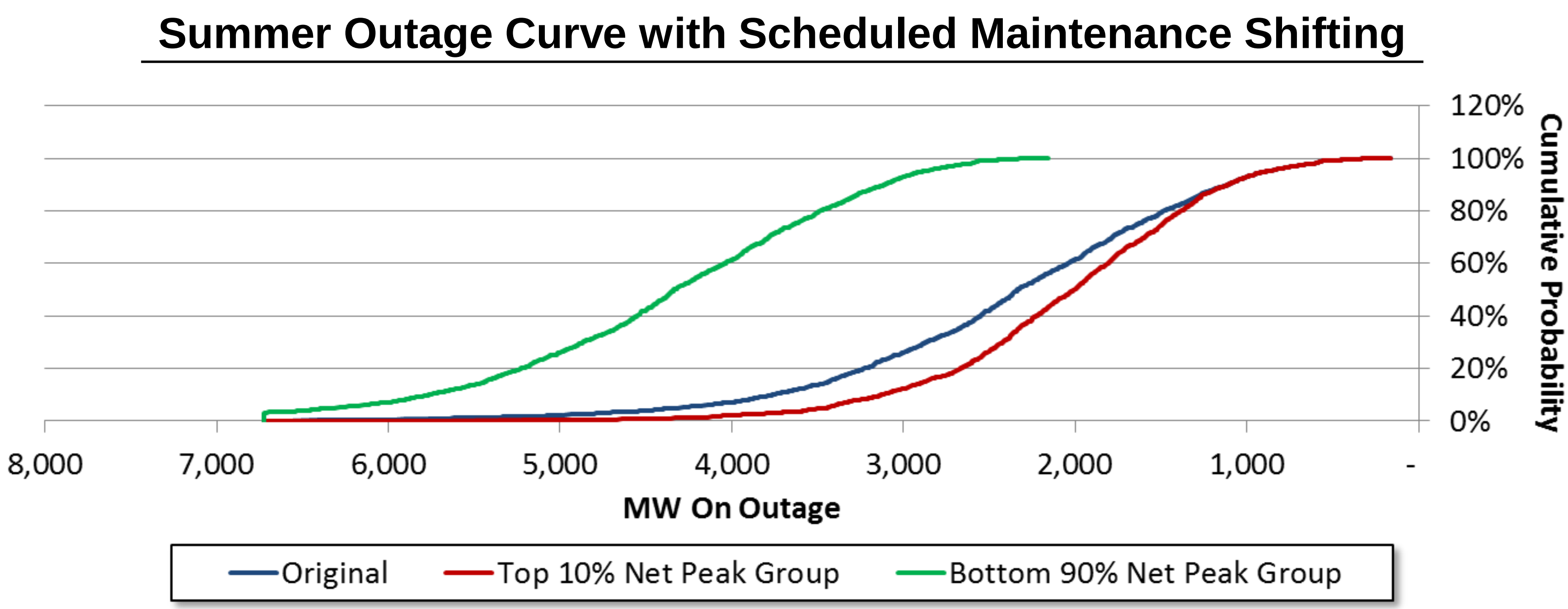
Forced and Scheduled Outages

- Repeat random sampling in PLEXOS is used to create a distribution of potential Forced and Scheduled outage draws for each season:



Maintenance Scheduling

- A 1,000 MW scheduled maintenance cap is put on high net load days to account for the ability to control and shift scheduled maintenance
- To account for lower maintenance in high net load days, additional maintenance is scheduled in low load days
  - Any maintenance amount can be put into the low net load draws without causing issues, as long as total stays below the highest potential draw



Maintenance Scheduling Sensitivity Analysis

- An exact maintenance cap is not known, however, there is an understanding that scheduled outages can be controlled and limited on stress days
- A range of maintenance caps are tested to see how sensitive the results are to the assumption

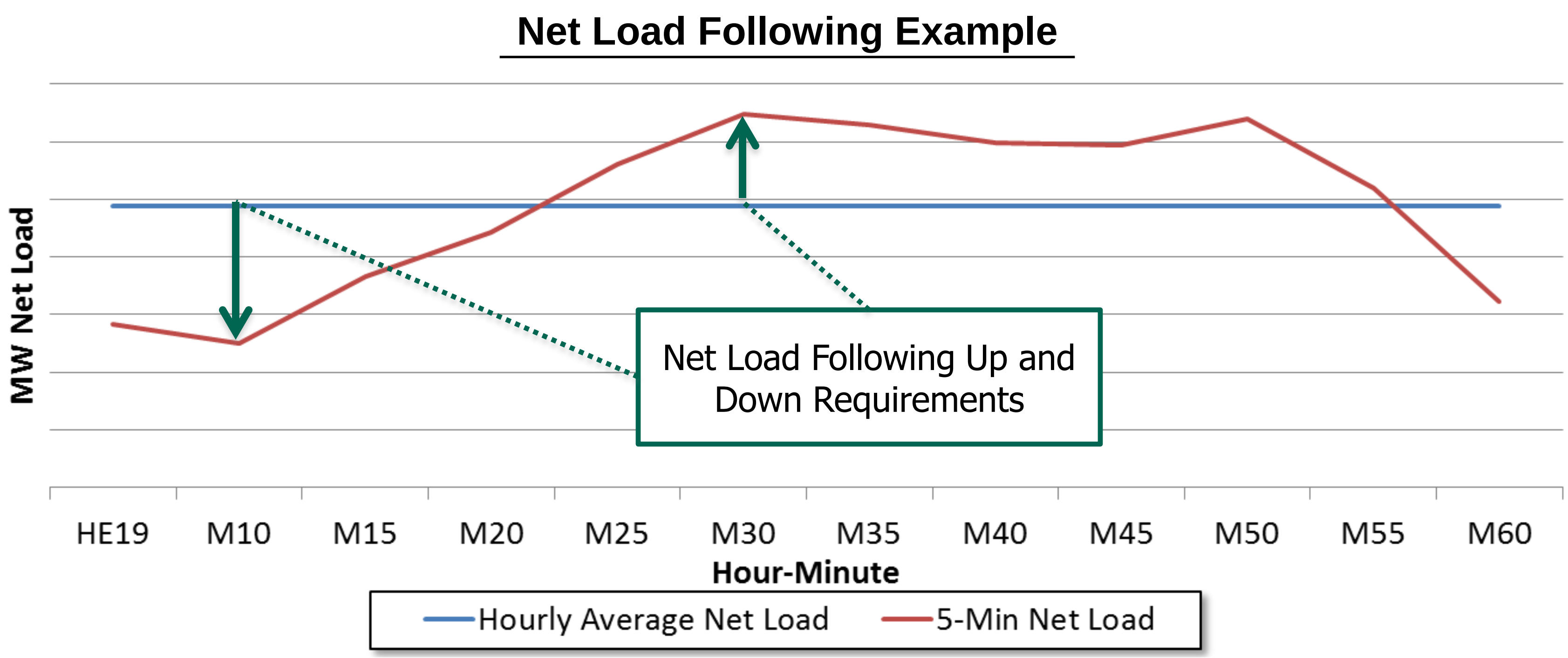
Expected Stage 3 Emergencies Using Different Scheduled Outage Cap Assumptions

Scheduled Outage MW Cap	Expected Stage 3 Emergency Events	MW Deficiency*
2,000	1.70	700
1,500	1.49	500
1,000	1.24	300
500	0.97	0
0	0.71	0

*Approximated Value. Deficiencies do not account for all the MWs that have been authorized for procurement (see slide 8)

Ancillary Service and Ramping Requirements

- **Regulation Up / Down** = 1.5% of CAISO Load
- **Spinning and Non Spinning Reserves** = 3% of CAISO Load
- **Net Load Following*** =Difference between 5-minute net load and hourly average net load (max difference across each hour)



*Only used for hourly dispatch decisions

CAISO Area Hydro Modeling

Overview

- Hydro modeling is based on 2005 historical operations data to ensure hydro plants operate in a feasible manner
- Hydro modeling is not stochastic, instead a single conservative input is chosen for each season

Run of River

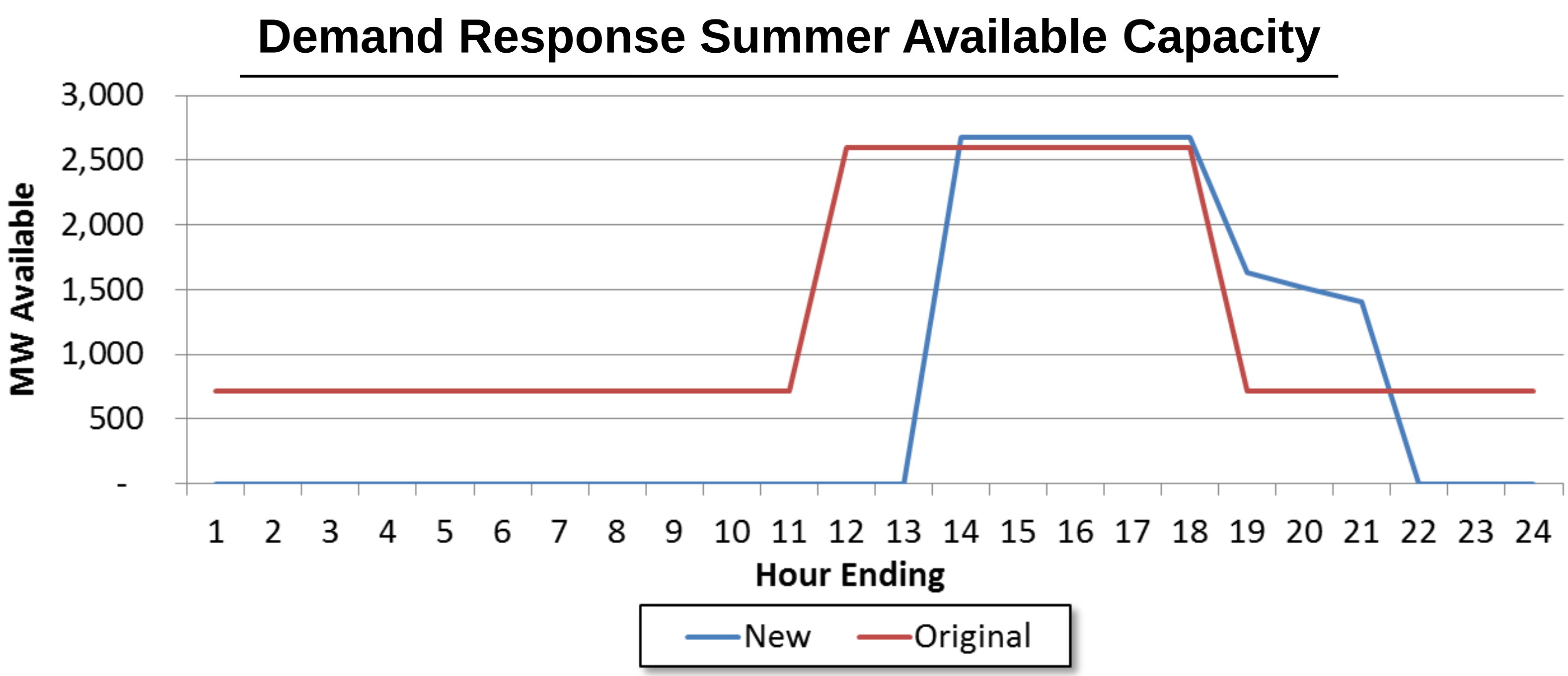
- The lowest energy production (GWh) day observed in a 2005 season is used as a fixed production shape for all draws for the 2022 season

Dispatchable Hydro

- The lowest energy production (GWh) week observed in a 2005 season is used as the weekly energy for all draws for the 2022 season
- The highest output (MW) and ramp (MW/min) observed in a 2005 season is used for all draws for the 2022 season

Demand Response (DR)

- SCE worked with the other IOU's to create a demand response forecast for 6pm through 9pm.
- While DR programs report dependable capacity from 1pm to 6pm for Resource Adequacy, there are no time of day restrictions for many programs.



Program Year 2011 Ex Ante Load Impacts, 1-in-2 Weather Year Condition, July System Monthly Peak.
Extended hour forecast performed for interruptible Demand Response Programs

Conclusions

Conclusions

1. SCE's analysis shows no additional resources needed in 2022 at this time to meet system needs when using the Base Case with SONGS Out Assumptions

2. 2022 operations may be tighter than 2012 operations

3. SCE's stochastic methodology captures the inherent uncertainties in key variables

4. SCE's analysis does not address over-generation in this LTPP proceeding

Thank You!
Questions / Comments:

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Probabilistic Reliability Planning Project

Donald Brooks

Prepared for LTPP workshop

September 18, 2013

California Public Utilities Commission

Overview of presentation

- Objective and Summary
- Brief intro - probabilistic reliability modeling
- Coordination effort
- Possible uses for the model
- Next Steps

Current status and project objectives

Where we are so far

- Energy Division has procured software from vendor, installed software, and are creating base case to model
- Four year license for the SERVM model from Astrape Consulting
- Energy Division is preparing database and training staff to support probabilistic reliability modeling

Project objectives

- Move from deterministic analysis to probabilistic analysis for LTPP and resource "need"
- Develop Effective Load Carrying Capability (ELCC) studies for wind/ solar resources – provide better quantification of capacity value relative to reduced system risk
- Compare and validate stakeholder studies (CAISO, SCE, etc.) and provide better analysis to the Commission

What is probabilistic reliability modeling? What is ELCC?

Brief intro - probabilistic reliability modeling – Loss of Load or Expected Unserved Energy

- Somewhat specialized field, lots of jargon
- Contrasting probabilistic with deterministic analysis – finding likely range of outcomes, not just most extreme or impactful
- Probabilistic modeling – statistical modeling relying on multiple iterations with multiple “draws” of certain stochastic variables
- Model a year one hour at a time, then model it again hundreds of times, total results and divide by number of iterations –expected value
- Allow for a study of the marginal reliability impacts of certain resources (ELCC)
- System resource adequacy metrics:
  - Frequency is expressed as percentage risk - Loss of Load Expectation (LOLE)
  - Magnitude/duration MWh of expected outage - Expected Unserved Energy (EUE)

Brief intro - ELCC

- ELCC is a study of the reliability benefit provided by the “marginal” target addition of capacity (such as wind or solar resources, individually or as a group) compared to standard “perfect” capacity
- Iterative – model entire system without target resource, add target resource and model again, then calibrate by adding alternative resources until reliability metrics equalize
- ELCC is ratio of Translation – adding MW of target resources decrease reliability indices equal to the MW of alternative “perfect” capacity

Probabilistic versus deterministic

Deterministic analysis	Probabilistic analysis
• Input one value for each input • Result of study is one value – generally most impactful or extreme case • Can model exact scenario – specify each and every variable • Find most extreme/most impactful result • Example – CAISO annual Local Capacity study, Transmission Planning study	• Input range of values, or one value with uncertainty bars • Result is expected range over range of inputs • Model variability around values – impact of variation/uncertainty in analysis • Find most likely range of results • Example – Annual installed capacity benefit margin study in NYISO

Common variables in probabilistic analysis

Common deterministic (unvarying) variables	Common stochastic (drawn from pool of values) variables
1. Size/operating characteristics of conventional generators, planned outage schedules	1. Forced outage rates/in service status of generators on hourly basis
2. Peak and energy demand totals for each month/year	2. Distribution of load shapes, weather
3. Must take non-dispatchable generation – run of river hydro	3. Intermittent non-dispatchable generation profiles – wind or solar facilities
4. Transmission ratings, MW capacity	4. Transmission outage rates

Applications of better analysis

Current processes

- Exceedence methodology for qualifying capacity – adopted in 2009
- Long term LTPP system analysis is deterministic, focused on peak, and unable to quantify uncertainty
- Energy Division produces analysis to support Commission action

Application for analysis

- Set QC via ELCC – mandated by SB 1x2 and in scope of R.11-10-032, proposal scheduled for Dec 2013
- LOLE analysis quantifies impact of variability of several variables at same time
- Energy Division staff is able to upgrade the quality of analysis and respond to inquiries faster.

Coordination

- Coordination with other state agencies
  - CAISO TPP and flexibility studies
  - CEC IEPR studies
- Coordination with other sections in Energy Division
  - LTPP long term planning scenarios
  - Demand Response program design and evaluation
  - Data coordination among multiple sections

Current status of database – projects to complete/upgrade data

- Key examples of current database is being developed
  - Development of hourly load shapes reflective of weather and split to areas of California
  - Development of hourly normalized load shapes for areas outside of California
  - Fully utilize GADS data to create individualized outage histories and unit specific outage information to use in modeling
  - Incorporate full range of data available for DR programs and program design – gauge variety of DR program designs, and reliability impacts of DR program designs
  - Quantify and understand diversity of hydro facilities
  - Production hourly profiles for wind and solar facilities for California and outside of California – quantify the correlations between weather and production for these facilities
  - Take advantage of as much existing analysis as possible

Next Steps

- Continue to train staff, develop base case
  - Lots of analysis going on – begin more regular phone calls with CAISO and CEC staff
  - Group of staff at CEC and CPUC are coordinating processes and inputs to perform some coordinated analysis (so far just training and getting ready, not producing reports yet)
  - Finalizing initial base case in September, begin modeling in October
  - Energy Division staff is preparing a proposal for how to calculate ELCC for wind and solar resources, and a proposal for study and analysis is scheduled for December 2013 pursuant to scoping memo in R.11-10-023
  - Continue to revise data and become more comfortable with probabilistic analysis.